# Exercise - I (Conceptual Questions) Build Up Your Understanding

## INTRODUCTION

**1.** Thermodynamics is concerned with :-
(1) Total energy of a system
(2) Energy changes in a system
(3) Rate of a chemical change
(4) Mass changes in nuclear reactions

**2.** A well stoppered thermos flask contains some ice cubes. This is an example of :–
(1) Closed system
(2) Open system
(3) Isolated system
(4) Non-thermodynamic system

**3.** Identify the intensive quantities from the following -
(1) Enthalpy and temperature
(2) Volume and temperature
(3) Enthalpy and volume
(4) Temperature and refractive index

**4.** Which of the following is an extensive property
(1) Mass (2) Enthalpy
(3) Energy (4) All of these

**5.** For an adiabatic process which of the following relations is correct
(1) $\Delta E = 0$ (2) $P\Delta V = 0$
(3) $q = 0$ (4) $q = + W$

**6.** In which of the following process work is independent of path :
(1) Isothermal (2) Isochoric
(3) Adiabatic (4) Isobaric

**7.** When a gas is compressed adiabatically and reversibly, the final temperature is-
(1) Higher than the initial temperature
(2) Lower than the initial temperature
(3) The same as initial temperature
(4) Dependent upon the rate of compression

**8.** Which one is dependent on initial and final state?
(1) Heat supplied at constant pressure
(2) Heat supplied at constant volume
(3) Enthalpy
(4) All of the above

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**9.** Out of boiling point (I), entropy (II), pH (III) and emf of a cell (IV), intensive properties are :
(1) I, III, IV (2) I, II
(3) I, II, III (4) All of these

**10.** The work done by a weightless piston in causing an expansion $\Delta V$ (at constant temperature), when the opposing pressure P is variable, is given by :
(1) $W = -\int PdV$ (2) $W = 0$
(3) $W = -P\Delta V$ (4) None

**11.** The work done by 100 calorie of heat in isothermal expansion of ideal gas is :-
(1) 418.4 J (2) 4.184 J
(3) 41.84 J (4) None

**12.** Temperature and volume are not :-
(1) Extensive properties
(2) Intensive properties
(3) Intensive and extensive properties respectively
(4) Extensive and intensive properties respectively

**13.** q = –w is not true for :-
(1) Isothermal process
(2) Adiabatic process
(3) Cyclic process
(4) 1 and 3 both

**14.** The temperature of an ideal gas increase in an -
(1) Adiabatic compression
(2) Adiabatic expansion
(3) Isothermal expansion
(4) Isothermal compression

**15.** Which statement is true for reversible process :–
(1) It takes place in single step
(2) Driving force is much greater than opposing force
(3) Work obtained is minimum
(4) None

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## FIRST LAW OF THERMODYNAMICS ($\Delta E = q + W$)

**16.** Both q & w are_ _ _ _ _ function :-
(1) State (2) State, Path
(3) Path, State (4) Path

**17.** If work done by the system is 300 joule when 100 cal. heat is supplied to it. The change in internal energy during the process is :-
(1) – 200 Joule (2) 400 Joule
(3) 720 Joule (4) 120 Joule

**18** A system has internal energy equal to $E_1$, 450 J of heat is taken out of it and 600 J of work is done on it. The final energy of the system will be -
(1) $(E_1 + 150)$ (2) $(E_1 + 1050)$
(3) $(E_1 – 150)$ (4) None of these

**19.** The work done by a system is 8J when 40J heat is supplied to it. The change in internal energy of the system during the process :
(1) 32 J (2) 40 J (3) 48 J (4) –32 J

## ENTHALPY [$\Delta H = \Delta E + P\Delta V / \Delta H = \Delta E + \Delta n_g RT$]

**20.** Internal energy change during a reversible isothermal expansion of an ideal gas is :-
(1) Always negative
(2) Always positive
(3) Zero
(4) May be positive or negative

**21.** Under which of the following conditions is the relation, $\Delta H = \Delta E + P\Delta V$ valid for a system :–
(1) Constant pressure
(2) Constant temperature
(3) Constant temperature and pressure
(4) Constant temperature, pressure and composition

**22.** The difference between heats of reaction at constant pressure and constant volume for the reaction
$2C_6H_6(l) + 15O_2(g) \longrightarrow 12CO_2(g) + 6H_2O(l)$ at $25^0C$ in KJ is
(1) + 7.43 (2) +3.72
(3) – 7.43 (4) – 3.72

**23.** For a gaseous reaction,
$A(g) + 3B(g) \longrightarrow 3C(g) + 3D(g)$
$\Delta$ E is 17 kCal at $27^0C$ assuming
R = 2 Cal $K^{-1}$ $mol^{-1}$, the value of $\Delta H$ for the above reaction is:
(1) 15.8 Kcal (2) 18.2 Kcal
(3) 20.0 Kcal (4) 16.4 Kcal

**24.** Which of the following statements is correct for the reaction ;
$2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$ at constant temperature and pressure
(1) $\Delta H = \Delta E$ (2) $\Delta H < \Delta E$
(3) $\Delta H > \Delta E$ (4) None of the above

**25.** For the reaction
$Ag_2O(s) \longrightarrow 2Ag(s) + ½\ O_2(g)$, which one of the following is true :
(1) $\Delta H = \Delta E$ (2) $\Delta H = ½\ \Delta E$
(3) $\Delta H < \Delta E$ (4) $\Delta H > \Delta E$

**26.** A mixture of 2 moles of carbon monoxide and one mole of oxygen in a closed vessel is ignited to get carbon dioxide. If $\Delta H$ is the enthalpy change and $\Delta E$ is the change in internal energy, then :–
(1) $\Delta H > \Delta E$ (2) $\Delta H < \Delta E$
(3) $\Delta H = \Delta E$ (4) Not definite

**27.** For the gaseous reaction involving the complete combustion of isobutane -
(1) $\Delta H = \Delta E$ (2) $\Delta H > \Delta E$
(3) $\Delta H = \Delta E = 0$ (4) $\Delta H < \Delta E$

**28.** For the reversible isothermal expansion of one mole of an ideal gas at 300 K, from a volume of 10 $dm^3$ to 20 $dm^3$, $\Delta H$ is -
(1) 1.73 kJ (2) –1.73 kJ
(3) 3.46 kJ (4) Zero

**29.** For $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ at 977°C, $\Delta H$ = 174 KJ/mol ; then $\Delta E$ is :-
(1) 160 kJ (2) 163.6 kJ
(3) 186.4 kJ (4) 180 kJ

**30.** Heat of reaction for,
$CO(g) + ½\ O_2(g) \rightarrow CO_2(g)$ at constant V is –67.71 K cal at 17°C. The heat of reaction at constant P at 17°C is :-
(1) –68.0 kCal (2) + 68.0 kCal
(3) – 67.42 kCal (4) None

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**31.** The enthalpy of vaporisation of water at $100^0$C is 40.63 kJ $mol^{-1}$. The value $\Delta E$ for this process would be:-
(1) 37.53 kJ $mol^{-1}$ (2) 39.08 kJ $mol^{-1}$
(3) 42.19 kJ $mol^{-1}$ (4) 43.73 kJ $mol^{-1}$

**32.** For the system $S(s) + O_2(g) \rightarrow SO_2(g)$ :–
(1) $\Delta H = \Delta E$ (2) $\Delta H > \Delta E$
(3) $\Delta E > \Delta H$ (4) $\Delta H = 0$

**33.** For the reaction $CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$
Which one of these statement is correct at constant T and P ?
(1) $\Delta H = \Delta E$
(2) $\Delta H < \Delta E$
(3) $\Delta H > \Delta E$
(4) $\Delta H$ is Independent of physical state of reactants

**34.** Which is true for the combustion of sucrose ($C_{12}H_{22}O_{11}$) at 25°C :-
(1) $\Delta H > \Delta E$ (2) $\Delta H < \Delta E$
(3) $\Delta H = \Delta E$ (4) None

**35.** For which change $\Delta H \neq \Delta E$ :-
(1) $H_2(g) + I_2(g) \rightarrow 2HI(g)$
(2) $HCl(\ell) + NaOH(\ell) \rightarrow NaCl(s) + H_2O(\ell)$
(3) $C(s) + O_2(g) \rightarrow CO_2(g)$
(4) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

**36.** The heat of combustion of ethanol determined in a bomb calorimeter is – 670.48 kCal $mole^{-1}$ at 27°C. What is $\Delta H$ at 27°C for the reaction :–
(1) – 335.24 kCal (2) – 671.08 kCal
(3) – 670.48 kCal (4) + 670.48 kCal

**37.** The difference in $\Delta H$ and $\Delta E$ for the combustion of methane at 25°C would be :–
(1) Zero (2) $2 \times 298 \times -2$ Cal
(3) $2 \times 298 \times -3$ Cal (4) $2 \times 25 \times -3$ Cal

**38.** For which of the following reactions $\Delta H$ is less than $\Delta E$ :–
(1) $C_{12}H_{22}O_{11}(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(\ell)$
(2) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$
(3) $N_2O_4(g) \rightarrow 2NO_2(g)$
(4) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

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**39.** For a reaction $2X(s) + 2Y(s) \rightarrow 2C(\ell) + D(g)$
The $q_p$ at 27°C is – 28 kCal $mol^{-1}$.
The $q_V$ is _____ kCal $mol^{-1}$ :–
(1) – 27.4 (2) + 27.4 (3) – 28.6 (4) 28.6

## WORK DONE IN DIFFERENT PROCESS

**40.** The work (in ergs) for a reversible expansion of one mole of an ideal gas from a volume of 10 litres to 20 litres at $25^0$C is :
(1) $-2.303 \times 8.314 \times 10^7 \times 298 \log 2$
(2) $-2.303 \times 0.0821 \times 298 \log 2$
(3) $-2.303 \times 0.0821 \times 298 \log 0.5$
(4) $-2.303 \times 2 \times 298 \log 2$

**41.** Two moles of an ideal gas expand spontaneously into vacuum. The work is :–
(1) Zero (2) 2 J (3) 4 J (4) 8 J

**42.** One mole of a gas occupying $3dm^3$ expands against a constant external pressure of 1 atm to a volume of 13 L. Find work is :–
(1) – 10 atm $dm^3$ (2) – 20 atm $dm^3$
(3) – 39 atm $dm^3$ (4) – 48 atm $dm^3$

## ENTROPY/SECOND LAW OF THERMODYNAMICS

**43.** For which reaction from the following, $\Delta S$ will be maximum ?
(1) $Ca(s) + ½\ O_2(g) \longrightarrow CaO(s)$
(2) $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$
(3) $C(s) + O_2(g) \longrightarrow CO_2(g)$
(4) $N_2(g) + O_2(g) \longrightarrow 2NO(g)$

**44.** An adiabatic reversible process is one in which :-
(1) Temperature of the system does not change
(2) The system is not closed to heat transfer
(3) There is no entropy change
(4) None of these

**45.** Entropy means
(1) Disorderness (2) Randomness
(3) Orderness (4) Both 1 & 2

**46.** $\Delta S$ for the reaction;
$MgCO_3(s) \longrightarrow MgO(s) + CO_2(g)$ will be :
(1) 0 (2) –ve (3) +ve (4) $\infty$

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**47.** Change in entropy is negative for

(1) $Br_2(\ell) \longrightarrow Br_2(g)$

(2) $C(s) + H_2O(g) \longrightarrow CO(g) + H_2(g)$

(3) $N_2(g, 10\ atm) \longrightarrow N_2(g, 1\ atm)$

(4) Fe(at 400 K) $\longrightarrow$ Fe(at 300 K)

**48.** In which reaction $\Delta S$ is positive :-

(1) $H_2O(\ell) \rightarrow H_2O(s)$

(2) $3O_2(g) \rightarrow 2O_3(g)$

(3) $H_2O(\ell) \rightarrow H_2O(g)$

(4) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

**49.** When the egg is hard boiled, there is-

(1) Increase in disorder

(2) Decrease in disorder

(3) No change in disorder

(4) $\Delta G$ is negative

**50.** If $S^0$ for $H_2$, $Cl_2$ and HCl are 0.13, 0.22 and 0.19 kJ $K^{-1}$ $mol^{-1}$ respectively. The total change in standard entropy for the reaction $H_2 + Cl_2 \longrightarrow 2HCl$ is :

(1) 30 $JK^{-1}$ $mol^{-1}$ (2) 40 $JK^{-1}$ $mol^{-1}$

(3) 60 $JK^{-1}$ $mol^{-1}$ (4) 20 $JK^{-1}$ $mol^{-1}$

**51.** Which has the least entropy :

(1) Graphite (2) Diamond

(3) $N_2(g)$ (4) $N_2O(g)$

**52.** When two gases are mixed the entropy :–

(1) Remains constant

(2) Decreases

(3) Increases

(4) Becomes zero

**53.** The enthalpy of vaporisation of per mole of ethanol (B.pt. = 79.5$^0$C and $\Delta S$ = 109.8 $JK^{-1}$ $mol^{-1}$) is :–

(1) 27.35 kJ $mol^{-1}$ (2) 32.19 kJ $mol^{-1}$

(3) 38.70 kJ $mol^{-1}$ (4) 42.37 kJ $mol^{-1}$

**54.** If 900J/g of heat is exchanged at boiling point of water, then what is increase in entropy?

(1) 43.4 $JK^{-1}mole^{-1}$ (2) 87.2 $JK^{-1}mole^{-1}$

(3) 900 $JK^{-1}mole^{-1}$ (4) Zero

**55.** 5 mole of an ideal gas expand reversibly from a volume of 8 $dm^3$ to 80$dm^3$ at a temperature of 27$^0$C. The change in entropy is :–

(1) 41.57 $JK^{-1}$ (2) – 95.73 $JK^{-1}$

(3) 95.73 $JK^{-1}$ (4) – 41.57 $JK^{-1}$

**56.** In a spontaneous irreversible process the total entropy of the system and surroundings

(1) Remains constant (2) Increases

(3) Decreases (4) Zero

**57.** The total entropy change for a system & its surroundings increases if the process is :

(1) Reversible (2) Spontaneous

(3) Exothermic (4) Endothermic

**58.** Calculate the entropy of $Br_2(g)$ in the reaction $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$, $\Delta S^\circ$ =20.1 $JK^{-1}$ given, entropy of $H_2$ and HBr is 130.6 and 198.5 J $mol^{-1}$ $K^{-1}$ :-

(1) 246.3 $JK^{-1}$ (2) 123.15 $JK^{-1}$

(3) 24.63 $JK^{-1}$ (4) 20 $kJK^{-1}$

**59.** In which of the following case entropy decreases–

(1) Solid changing to liquid

(2) Expansion of a gas

(3) Crystals dissolve

(4) Polymerisation

**60.** Which of the following quantity is not zero for element in standard state :–

(1) Enthalpy of formation

(2) Entropy

(3) Free energy of formation

(4) All of these

**61.** Entropy of an adiabatic reversible process is:-

(1) Positive (2) Zero

(3) Negative (4) Constant

## GIBBS FREE ENERGY

**62.** A gas is allowed to expand under reversible adiabatic conditions then :-

(1) $\Delta U = 0$ (2) $\Delta T = 0$

(3) $\Delta S = 0$ (4) None of these

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**63.** For a reaction at 25°C enthalpy change ($\Delta H$) and entropy change ($\Delta S$) are $-11.7 \times 10^3$ $Jmol^{-1}$ and $-105$ J $mol^{-1}$ $K^{-1}$ respectively. The reaction is :
(1) Spontaneous
(2) Non spontaneous
(3) At equilibrium
(4) Can't say anything

**64.** If $\Delta H > 0$ and $\Delta S > 0$, the reaction proceeds spontaneously when :-
(1) $\Delta H > 0$ (2) $\Delta H < T\Delta S$
(3) $\Delta H = T\Delta S$ (4) None

**65.** The temperature at which the reaction
$Ag_2O(s) \longrightarrow 2Ag(s) + \frac{1}{2} O_2(g)$
is at equilibrium is .....;
Given $\Delta H = 30.5$ kJ $mol^{-1}$
and $\Delta S = 0.066$ $kJK^{-1}$ $mol^{-1}$ :
(1) 462.12 K (2) 362.12 K
(3) 262.12 K (4) 562.12 K

**66.** Which of the following is true for the reaction $H_2O(\ell) \rightleftharpoons H_2O(g)$ at 100°C and 1 atmosphere
(1) $\Delta S = 0$ (2) $\Delta H = 0$
(3) $\Delta H = \Delta E$ (4) $\Delta H = T\Delta S$

**67.** For the reaction $A(s) \longrightarrow B(s) + C(g)$ the value of $\Delta H = 30.56$ kJ $mol^{-1}$ and $\Delta S = 66$ $JK^{-1}$ $mol^{-1}$. The temperature at which the free energy change for the reaction will be zero is :–
(1) 373 K (2) 413 K (3) 463 K (4) 493 K

**68.** For hypothetical reversible reaction
$\frac{1}{2} A_2(g) + \frac{3}{2} B_2(g) \longrightarrow AB_3(g)$; $\Delta H = -20$ kJ if standard entropies of $A_2$, $B_2$ and $AB_3$ are 60, 40 and 50 $JK^{-1}$ $mole^{-1}$ respectively. The above reaction will be in equilibrium at :–
(1) 400 K (2) 500 K (3) 250 K (4) 200 K

**69.** For the precipitation of AgCl by $Ag^+$ ions and HCl
(1) $\Delta H = 0$ (2) $\Delta G = 0$
(3) $\Delta G = -ve$ (4) $\Delta H = \Delta G$

**70.** What is the sign of $\Delta G$ for the process of ice melting at 1 atm, 283 K is ?
(1) $\Delta G > 0$ (2) $\Delta G = 0$
(3) $\Delta G < 0$ (4) None of these

**71.** A reaction $A + B \longrightarrow C + D + q$ is found to have a positive entropy change, the reaction will be -
(1) Possible at high temperature
(2) Possible only at low temperature
(3) Not possible at any temperature
(4) Possible at any temperature

**72.** Equilibrium constant of a reaction is related to :
(1) Standard free energy change $\Delta G^0$
(2) Free energy change $\Delta G$
(3) Entropy change
(4) None

**73.** The Vant Hoff equation is :
(1) $\Delta G^\circ = RT \log_e K_P$ (2) $-\Delta G^\circ = RT \log_e K_P$
(3) $\Delta G^\circ = RT^2 \ell n K_P$ (4) None

**74.** If $\Delta G^0 > 0$ for a reaction then :
(1) $K_P > 1$
(2) $K_P < 1$
(3) The products predominate in the equilibrium mixture
(4) None

**75.** If the equilibrium constant for a reaction is 10, then the value of $\Delta G^0$ will be
(R = 8$JK^{-1}$ $mol^{-1}$, T = 300 K)
(1) + 5.527 kJ $mol^{-1}$ (2) – 5.527 kJ $mol^{-1}$
(3) +55.27 kJ $mol^{-1}$ (4) – 55.27 kJ $mol^{-1}$

**76.** The process of evaporation of a liquid is accompanied by :
(1) Increase in enthalpy
(2) Decrease in free energy
(3) Increase in entropy
(4) All

**77.** For the process, $CO_2(s) \longrightarrow CO_2(g)$ :
(1) Both $\Delta H$ and $\Delta S$ are +ve
(2) $\Delta H$ is negative and $\Delta S$ is +ve
(3) $\Delta H$ is +ve and $\Delta S$ is –ve
(4) Both $\Delta H$ and $\Delta S$ are –ve

**78.** Which of the following provide exceptions to third law of thermodynamics
(1) CO (2) ice
(3) $CO_2$ (4) All the above

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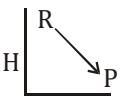
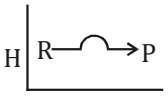
**79.** The Gibbs free energy change of a reaction at 27°C is –26 kCal and its entropy change is – 60 Cal $K^{-1}$. $\Delta H$ for the reaction is :–
(1) – 44 kCal (2) – 18 kCal
(3) 34 kCal (4) – 24 kCal

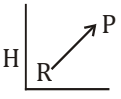
**80.** Which of the following reaction is expected never to be spontaneous :–
(1) $2O_3(g) \rightarrow 3O_2(g)$
$\Delta H$ = – Ve, $\Delta S$ = +Ve
(2) $Mg(s) + H_2(g) \rightarrow MgH_2$
$\Delta H$ = – Ve, $\Delta S$ = – Ve
(3) $Br_2(I) \rightarrow Br_2(g)$
$\Delta H$ = + Ve, $\Delta S$ = + Ve
(4) $2Ag(s) + 3N_2(g) \rightarrow 2AgN_3$
$\Delta H$ = +Ve, $\Delta S$=– Ve

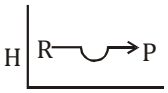
## THERMOCHEMICAL REACTION

**81.** The formation of water from $H_2(g)$ and $O_2(g)$ is an exothermic process because :
(1) The chemical energy of $H_2(g)$ and $O_2(g)$ is more than that of water
(2) The chemical energy of $H_2(g)$ and $O_2(g)$ is less than that of water
(3) The temperature of $H_2(g)$ and $O_2(g)$ is higher than that of water
(4) The temperature of $H_2(g)$ and $O_2(g)$ is lower than that of water

**82.** Which plot represents for an exothermic reaction:
(1) 

(2) 

(3) 

(4) 


**83.** Which one of the following is not applicable for a thermochemical equation :
(1) It tells about physical state of reactants and products
(2) It tells whether the reaction is spontaneous
(3) It tells whether the reaction is exothermic or endothermic
(4) It tells about the allotropic form (if any) of the reactants

**84.** The correct thermochemical equation is :
(1) $C + O_2 \longrightarrow CO_2$ ; $\Delta H$ = – 94 kCal
(2) $C + O_2 \longrightarrow CO_2$ ; $\Delta H$ = + 94.0 kCal
(3) $C(s) + O_2(g) \longrightarrow CO_2(g)$ ; $\Delta H$ = –94 kCal
(4) $C(s) + O_2(g) \longrightarrow CO_2(g)$; $\Delta H$ = +94 kCal

**85.** The enthalpy changes of formation of the gaseous oxide of nitrogen ($N_2O$ and NO) are positive because of :
(1) The high bond energy of the nitrogen molecule
(2) The high electron affinity of oxygen atoms
(3) The high electron affinity of nitrogen atoms
(4) The tendency of oxygen to form $O^{2-}$

**86.** $\Delta H$ for transition of carbon from diamond form to graphite form is – 453.5 Cal. This suggests that :
(1) Graphite is chemically different from diamond
(2) Graphite is as stable as diamond
(3) Graphite is more stable than diamond
(4) Diamond is more stable than graphite

**87.** Which of the following values of heat of formation indicates that the product is least stable
(1) – 94 kCal (2) – 231.6 kCal
(3) + 21.4 kCal (4) + 64.8 kCal

**88.** Heat of formation, $\Delta H_f^\circ$ of an explosive compound like $NCl_3$ is –
(1) Positive
(2) Negative
(3) Zero
(4) Positive or negative

**89.** According to the following reaction
$C(s) + 1/2\ O_2(g) \rightarrow CO(g)$, $\Delta H$ = - 26.4 kCal
(1) CO is an endothermic compound
(2) CO is an exothermic compound
(3) The reaction is endothermic
(4) None of the above

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**90.** Which of the following represents an exothermic reaction:-
(1) $N_2(g) + O_2(g) \rightarrow 2NO(g)$, $\Delta H = 180.5$ kJ
(2) $H_2O(g) + C(s) \rightarrow CO(g) + H_2(g)$, $\Delta E = 131.2$ kJ
(3) $2HgO(s) + 180.4$ KJ $\rightarrow 2Hg(\ell) + O_2(g)$
(4) $2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$, $\Delta E = -693.8$ kJ

**91.** Consider the reaction $3O_2 \rightarrow 2O_3$ ; $\Delta H$ = + Ve, from the reaction, we can say that :–
(1) Ozone is more stable then oxygen
(2) Ozone is less stable then oxygen and ozone decomposes forming oxygen readily
(3) Oxygen is less stable than ozone and oxygen decomposes forming ozone readily
(4) None of the above

**92.** From the reaction P(White) $\rightarrow$ P(Red) ; $\Delta H = -18.4$ kJ, it follows that :-
(1) Red P is readily formed from white P
(2) White P is readily formed from red P
(3) White P can not be converted to red P
(4) White P can be converted into red P and red P is more stable

## FACTORS AFFECTING HEAT OF REACTION

**93.** In Kirchoff's equation which factor affects the heat of reaction :
(1) Pressure (2) Temperature
(3) Volume (4) Atomicity

**94.** The enthalpy of a reaction at 273 K is –3.57 kJ. what will be the enthalpy of reaction at 373 K if $\Delta C_p$ = zero :–
(1) – 3.57 kJ (2) Zero
(3) $-3.57 \times \frac{373}{273}$ kJ (4) – 375 kJ

**95.** For the reactions,
(i) $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g) + x$ kJ
(ii) $H_2(g) + Cl_2(g) \longrightarrow 2HCl(\ell) + y$ kJ
Which one of the following statement is correct :
(1) x > y (2) x < y
(3) x = y (4) More data required

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## HEAT OF FORMATION

**96.** Since the enthalpy of formation of the elements in their standard states is taken to be zero. The heat of formation ($\Delta H_f$ ) of compounds :
(1) Is always negative
(2) Is always positive
(3) Is zero
(4) May be positive or negative

**97.** Reaction $H_2(s) + I_2(g) \longrightarrow 2HI$; $\Delta H = 12.40$ kCal. According to this, heat of formation of HI will be –
(1) 12.40 kCal (2) – 12.40 kCal
(3) – 6.20 kCal (4) 6.20 kCal

**98.** Enthalpy of a compound is equal to its :- (When it is formed from reference state of constituent elements)
(1) Heat of combustion (2) Heat of formation
(3) Heat of reaction (4) Heat of solution

**99.** Which of the following equations respresents standard heat of formation of $CH_4$ ?
(1) $C_{(diamond)} + 2H_{2\,(g)} \longrightarrow CH_{4(g)}$
(2) $C_{(graphite)} + 2H_{2\,(g)} \longrightarrow CH_{4(g)}$
(3) $C_{(diamond)} + 4H_{(g)} \longrightarrow CH_{4(g)}$
(4) $C_{(graphite)} + 4H_{(g)} \longrightarrow CH_{4(g)}$

**100.** The enthalpy of formation of ammonia is –46.0 kJ $mol^{-1}$. The enthalpy change for the reaction $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$ is :
(1) 46.0 kJ $mol^{-1}$ (2) 92.0 kJ $mol^{-1}$
(3) – 23.0 kJ $mol^{-1}$ (4) – 92.0 kJ $mol^{-1}$

**101.** Given enthalpy of formation of $CO_2(g)$ and CaO(s) are – 94.0 kJ and – 152 kJ respectively and the enthalpy of the reaction :
$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$ is 42 kJ. The enthalpy of formation of $CaCO_3(s)$ is
(1) – 42 KJ (2) – 202 KJ
(3) +202 KJ (4) – 288KJ

**102.** Given that standard enthalpy of formation of $CH_4$, $C_2H_4$ and $C_3H_8$ are –17.9, 12.5, –24.8 kCal $mol^{-1}$. The $\Delta H$ for $CH_4 + C_2H_4 \rightarrow C_3H_8$ is :
(1) – 55.2 kCal (2) – 30.2 kCal
(3) 55.2 kCal (4) – 19.4 kCal

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**103.** The standard molar heat of formation of ethane, $CO_2$ and water are respectively –21.1, –94.1 and – 68.3 kCal. The standard molar heat of combustion of ethane will be
(1) –372 kCal (2) –162 kCal
(3) – 240 kCal (4) –183.5 kCal

**104.** The $\Delta H_f^o$ for $CO_{2(g)}$, $CO_{(g)}$ and $H_2O_{(g)}$ are –393.5, –110.5 and –241.8 kJ $mol^{-1}$ respectively the standard enthalpy change (in kJ) for the reaction
$CO_{2(g)} + H_{2(g)} \rightarrow CO_{(g)} + H_2O_{(g)}$ is -
(1) 524.1 (2) 41.2
(3) –262.5 (4) –41.2

**105.** The enthalpies of combustion of carbon and carbon monoxide are –393.5 kJ and –283 kJ, respectively the enthalpy of formation of carbon monoxide is :
(1) –676.5 kJ (2) –110.5 kJ
(3) 110.5 kJ (4) 676.5 kJ

**106.** The standard heat of formation of $CS_2(\ell)$ will be; given that the standard heat of combustion of carbon (s), sulphur(s) and $CS_2(\ell)$ are –393.3, –293.72 and –1108.76 kJ $mol^{-1}$ respectively is
(1) –128.02 kJ $mole^{-1}$ (2) +12.802 kJ $mol^{-1}$
(3) +128.02 kJ $mol^{-1}$ (4) –12.802 kJ $mol^{-1}$

**107.** The heat of combustion of $CH_{4(g)}$, $C_{(s)}$ and $H_{2(g)}$ at 25 °C are –212.4 K Cal, –94.0 K Cal and –68.4 K Cal respectively, the heat of formation of $CH_4$ will be -
(1) +54.4 K Cal (2) –18.4 K Cal
(3) –375.2 K Cal (4) +212.8 K Cal

**108.** Standard enthalpy of formation is zero for.
(1) $C_{diamond}$ (2) $Br_{(g)}$
(3) $C_{graphite}$ (4) $O_{3(g)}$

**109.** The standard heats of formation of $NO_2(g)$ and $N_2O_4(g)$ are 8.0 and 2.0 kCal $mol^{-1}$ respectively the heat of dimerization of $NO_2$ in kCal is
(1) 10.0 (2) –6.0 (3) –12.0 (4) –14.0

**110.** M is a metal that forms an oxide $M_2O$

$$\frac{1}{2}M_2O \rightarrow M + \frac{1}{4}O_2 \quad \Delta H = 120 \text{ kCal}$$

When a sample of metal M reacts with one mole of oxygen what will be the $\Delta H$ in that case
(1) 240 kCal (2) – 240 kCal
(3) 480 kCal (4) – 480 kCal

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## HEAT OF COMBUSTION

**111.** According to equation,
$C_6H_6(\ell) + 15/2\ O_2(g) \rightarrow 6CO_2(g) + 3H_2O(\ell)$; $\Delta H$ = – 3264.4 kJ $mol^{-1}$ the energy evolved when 7.8 g benzene is burnt in air will be -
(1) 163.22 kJ (2) 32.64 kJ
(3) 3.264 kJ (4) 326.4 kJ

**112.** Heat of combustion of $CH_4$,$C_2H_6$, $C_2H_4$ and $C_2H_2$ gases are –212.8, –373.0, –337.0 and –310.5 kCal respectively at the same temperature. The best fuel among these gases is :
(1) $CH_4$ (2) $C_2H_6$ (3) $C_2H_4$ (4) $C_2H_2$

**113.** Given standard enthalpy of formation of CO (–110 kJ $mol^{-1}$) and $CO_2$(–394 kJ $mol^{-1}$). The heat of combustion when one mole of graphite burns is
(1) – 110 kJ (2) – 284 kJ
(3) – 394 kJ (4) – 504 kJ

**114.** The enthalpy of formation for $C_2H_4(g)$, $CO_2(g)$ and $H_2O(\ell)$ at 25°C and 1 atm. pressure are 52, – 394 and – 286 kJ $mole^{-1}$ respectively. The enthalpy of combustion of $C_2H_4$ will be:-
(1) + 1412 kJ $mole^{-1}$ (2) –1412 kJ $mole^{-1}$
(3) + 142.2 kJ $mole^{-1}$ (4) –141.2 kJ $mole^{-1}$

**115.** The combustion of one mole of benzene takes place at 298 K and 1 atm. After combustion, $CO_2(g)$ and $H_2O(l)$ are produced and 3267.0 kJ of heat is liberated. Calculate the standard enthalpy of formation, $\Delta_f H^\circ$ of benzene.
Standard enthalpies of formation of $CO_2(g)$ and $H_2O(l)$ are –393.5 kJ $mol^{-1}$ and –285.83 kJ $mol^{-1}$ respectively.
(1) 48.51 kJ $mol^{-1}$ (2) –48.51 kJ $mol^{-1}$
(3) –97.02 kJ $mol^{-1}$ (4) 97.02 kJ $mol^{-1}$

**116.** The heat evolved during the combustion of 112 litre of water gas at STP (mixture of equal volume of $H_2$ and CO) is : Given
$H_2(g) + ½\ O_2(g) \rightarrow H_2O(g)$ ; $\Delta H$ = –241.8 kJ
$CO(g) + ½\ O_2(g) \rightarrow CO_2(g)$ ; $\Delta H$ = –283 kJ
(1) 241.8 kJ (2) 283 kJ
(3) 1312 kJ (4) 1586 kJ

**117.** A person requires 2870 kCal of energy to lead normal daily life. If heat of combustion of cane sugar is $-1349$ kCalmol$^{-1}$, then his daily consumption of sugar is :
(1) 728 g (2) 0.728 g
(3) 342 g (4) 0.342 g

**118.** The following are the heats of reactions -
(i) $\Delta H_f^o$ of $H_2O_{(\ell)} = -68.3$ kCal mol$^{-1}$
(ii) $\Delta H_{comb.}^o$ of $C_2H_2 = -337.2$ kCal mol$^{-1}$
(iii) $\Delta H_{comb.}^o$ of $C_2H_4 = -363.7$ kCal mol$^{-1}$
Then heat change for the reaction
$C_2H_2 + H_2 \rightarrow C_2H_4$ is -
(1) $-716.1$ kCal (2) + 337.2 kCal
(3) $-41.8$ kCal (4) $-579.5$ kCal

**119.** The heat of combustion of a substance is :-
(1) Always positive
(2) Always negative
(3) Numerically equal to the heat of formation
(4) 1 and 3 both

**120.** The value of $\Delta H$ for the combustion of C(s) is $-94.4$ kCal. The heat of formation of $CO_2(g)$ is :-
(1) $-49.5$ kCal
(2) $-94.4$ kCal
(3) $-188.0$ kCal
(4) More data required

**121.** In the combustion of 0.4 g. of $CH_4$, 0.25 kCal. of heat is liberated. The heat of combustion of $CH_4$ is
(1) – 20 kCal (2) – 10 kCal
(3) – 2.5 kCal (4) – 5 kCal

**122.** If $C_6H_{12}O_6(s) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$; $\Delta H$ = – 680 kCal The weight of $CO_2(g)$ produced when 170 kCal of heat is evolved in the combustion of glucose is:-
(1) 265 g (2) 66 g (3) 11 g (4) 64 g

**123.** Which of the following equations corresponds to the enthalpy of combustion at 298 K :-
(1) $C_2H_6(g) + 7/2\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$
(2) $2C_2H_6(g) + 7\ O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$
(3) $C_2H_6(g) + 7/2\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$
(4) $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(\ell)$

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**124.** Heat of formation of $CO_2$ is – 94.0 kCal. What would be the quantity of heat liberated, when 3 g of graphite is burnt in excess of oxygen:-
(1) 23.5 kCal (2) 2.35 kCal
(3) 94.0 kCal (4) 31.3 kCal

## HEAT OF NEUTRALIZATION

**125.** The amount of heat liberated when one mole of $NH_4OH$ reacts with one mole of HCl is
(1) 13.7 kCal
(2) More than 13.7 kCal
(3) Less than 13.7 kCal
(4) Cannot be predicted

**126.** If $H^+ + OH^- = H_2O + 13.7$ kCal, then heat of complete neutralisation of one gram mole of $H_2SO_4$ with strong base will be :
(1) $-13.7$ kcal (2) $-27.4$ kcal
(3) $-6.85$ kcal (4) $-3.425$ kCal

**127.** Heat of neutralisation of a strong dibasic acid in dilute solution by NaOH is nearly :
(1) – 27.4 kCal eq$^{-1}$ (2) – 13.7 kCal eq$^{-1}$
(3) 13.7 kCal eq$^{-1}$ (4) – 13.7 kCal mol$^{-1}$

**128.** The temperature of a 5 ml of strong acid increases by $5^0$C when 5 ml of a strong base is added to it. If 10 ml of each are mixed temperature should increase by :
(1) $5^0$ C (2) $10^0$C
(3) $15^0$C (4) Cannot be known

**129.** The heat of neutralization of HCl by NaOH is $-55.9$ kJ mol$^{-1}$. If the heat of neutralization of HCN by NaOH is – 12.1 kJ mol$^{-1}$. The energy of dissociation of HCN is
(1) $-43.8$ kJ (2) 43.8 kJ
(3) 68 kJ (4) – 68 kJ

**130.** If water is formed from $H^+$ ions and $OH^-$ the heat exchange during the reaction :
(1) – 13.7 kCal (2) 13.7 kCal
(3) $-63.4$ kCal (4) More data required

**131.** The change in the enthalpy of
$NaOH + HCl \longrightarrow NaCl + H_2O$ is called :
(1) Heat of neutralisation
(2) Heat of reaction
(3) Heat of hydration
(4) Heat of solution

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## HEAT OF HYDROGENATION

**132.** The heat of combustion of $C_2H_4$, $C_2H_6$ and $H_2$ are –1409.5 kJ, –1558.3 kJ and –285.6 kJ. The heat of hydrogenation of ethene is -
(1) –136.8 kJ (2) –13.68 kJ
(3) 273.6 kJ (4) 1.368 kJ

**133.** The enthalpy of combustion of cyclohexane, cyclohexene and $H_2$ are respectively –3920, –3800 and –241 kJ $mol^{-1}$. The heat of hydrogenation of cyclohexene is:-
(1) –121 kJ $mol^{-1}$ (2) 121 kJ $mol^{-1}$
(3) –242 kJ $mol^{-1}$ (4) 242 kJ $mol^{-1}$

## BOND ENERGY/RESONANCE ENERGY

**134.** Bond energy of a molecule :
(1) Is always negative
(2) Is always positive
(3) Either positive or negative
(4) Depends upon the physical state of the system

**135.** Among the following for which reaction heat of reaction represents bond energy of HCl
(1) $HCl(g) \longrightarrow H^+(g) + Cl^-(g)$
(2) $HCl(g) \longrightarrow \frac{1}{2} H_2(g) + \frac{1}{2} Cl_2(g)$
(3) $2HCl(g) \longrightarrow H_2(g) + Cl_2(g)$
(4) $HCl(g) \longrightarrow H(g) + Cl(g)$

**136.** The bond energies of $F_2$, $Cl_2$, $Br_2$ and $I_2$ are 155.4, 243.6, 193.2 and 151.2 kJ $mol^{-1}$ respectively. The strongest bond is :
(1) F – F (2) Cl – Cl
(3) Br – Br (4) I – I

**137.** Energy required to dissociate 4g of gaseous hydrogen into free gaseous atoms is 208 kCal at $25^0$C. The bond energy of H—H bond will be :
(1) 1.04 kCal (2) 10.4 kCal
(3) 104 kCal (4) 1040 kCal

**138.** Heat evolved in the reaction
$H_2 + Cl_2 \longrightarrow 2HCl$ is 182 kJ. Bond energies of H–H and Cl–Cl are 430 and 242 kJ $mol^{-1}$ respectively. The H–Cl bond energy is :
(1) 245 kJ $mol^{-1}$ (2) 427 kJ $mol^{-1}$
(3) 336 kJ $mol^{-1}$ (4) 154 kJ $mol^{-1}$

**139.** The enthalpy change for the reaction
$H_2(g) + C_2H_4(g) \rightarrow C_2H_6(g)$ is ..... The bond energies are in kCal $mol^{-1}$
H – H = 103, C – H = 99, C – C = 80 & C = C =145
(1) –10 kCal $mol^{-1}$ (2) +10 kCal $mol^{-1}$
(3) – 30 kCal $mol^{-1}$ (4) +30 kCal $mol^{-1}$

**140.** Bond dissociation enthalphies of $H_2(g)$ and $N_2(g)$ are 436.0 kJ $mol^{-1}$ and 941.8 kJ $mol^{-1}$ respectively and enthalpy of formation of $NH_3(g)$ is –46 kJ $mol^{-1}$. What is enthalpy of atomization of $NH_3(g)$ ?
(1) 390.3 kJ $mol^{-1}$ (2) 1170.9 kJ $mol^{-1}$
(3) 590 kJ $mol^{-1}$ (4) 720 kJ $mol^{-1}$

**141.** From the reactions :
$C(s) + 2H_2(g) \rightarrow CH_4(g)$ $\Delta H = -X$ kcal
$C(g) + 4H(g) \rightarrow CH_4(g)$, $\Delta H = -X_1$ kcal
$CH_4(g) \rightarrow CH_3(g) + H(g)$ $\Delta H = +Y$ kcal
Bond energy of C–H bond is –
(1) $\frac{X}{4}$ kCal $mol^{-1}$ (2) Y kCal $mol^{-1}$
(3) $\frac{X_1}{4}$ kCal $mol^{-1}$ (4) $X_1$ kCal $mol^{-1}$

**142.** The enthalpy changes at 298 K in successive breaking of O–H bonds of water are
$H_2O \longrightarrow H(g) + OH(g)$ ; $\Delta H = 498$ kJ $mol^{-1}$
$OH(g) \longrightarrow H(g) + O(g)$ ; $\Delta H = 428$ kJ$mol^{-1}$
the bond enthalpy of O–H bond is
(1) 498 kJ $mol^{-1}$ (2) 428 kJ $mol^{-1}$
(3) 70 kJ $mol^{-1}$ (4) 463 kJ $mol^{-1}$

**143.** If $\Delta H_f^\circ$ of $ICl_{(g)}$, $Cl_{(g)}$, and $I_{(g)}$ is 17.57, 121.34 and 106.96 J $mol^{-1}$ respectively. Then bond dissociation energy of ICl bond is -
(1) 35.15 J $mol^{-1}$ (2) 106.69 J $mol^{-1}$
(3) 210.73 J $mol^{-1}$ (4) 420.9 J $mol^{-1}$

**144.** Heat of dissociation of benzene to elements is 5535 kJ $mol^{-1}$. The bond enthalpies of C–C, C=C and C–H are 347.3, 615.0 and 416.2 kJ respectively. Magnitude of resonance energy of benzene is
(1) 1.51 kJ (2) 15.1 kJ
(3) 151 kJ (4) 1511 kJ

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## SOME OTHER HEAT OF REACTIONS

**145.** The enthalpy change for the reaction $2C(graphite) + 3H_2(g) \longrightarrow C_2H_6(g)$ is called
(1) Enthalpy of formation
(2) Enthalpy of combustion
(3) Enthalpy of hydrogenation
(4) Enthalpy of vaporisation

**146.** $Cl_2(g) \longrightarrow 2Cl(g)$, In this process value of $\Delta H$ will be -
(1) Positive
(2) Negative
(3) Zero
(4) Nothing can be predicted

**147.** The magnitude of heat of solution ..... on addition of solvent to solution
(1) Decreases
(2) Increases
(3) Remains constant
(4) Increases or decreases

**148.** If $H_2(g) \longrightarrow 2H(g)$ ; $\Delta H = 104$ kCal, than heat of atomisation of hydrogen is :
(1) 52 kCal (2) 104 kCal
(3) 208 kCal (4) None of these

**149.** $S_{(rhombic)} + O_{2(g)} \longrightarrow SO_{2(g)}$ ; $\Delta H = -297.5$ kJ
$S_{(monoclinic)} + O_{2\ (g)} \longrightarrow SO_2$ ; $\Delta H = -300$ kJ
The data can predict that –
(1) Rhombic sulphur is yellow in colour
(2) Monoclinic sulphur has metallic lusture.
(3) Monoclinic sulphur is more stable
(4) $\Delta H$ transition of $S_R$ to $S_M$ is endothermic

**150.** The heat of combustion of yellow phosphorous and red phosphorous are – 9.91 kJ and –8.78 kJ respectively. The heat of transition of yellow phosphorous to red phosphorous is
(1) –18.69 kJ (2) +1.13 kJ
(3) +18.69 kJ (4) –1.13 kJ

**151.** $2CO_{(g)} + O_{2(g)} \longrightarrow 2CO_{2(g)} + X$ kJ
In the above equation X kJ refers to :
(1) Heat of formation of $CO_2$
(2) Heat of vapourisation
(3) Heat of reaction
(4) Heat of sublimation

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**152.** $\Delta H$ for the reaction, $I_{(g)} + I_{(g)} \rightarrow I_2(g)$ will be:-
(1) Zero (2) – ve (3) + ve (4) $\infty$

**153.** Given that :

$A(s) \xrightarrow{TK} A(\ell)$ ; $\Delta H = x$,

$A(\ell) \xrightarrow{TK} A(g)$ ; $\Delta H = y$

Calculate enthalpy of sublimation at 'T'K :-
(1) x + y (2) x - y
(3) x or y (4) - (x + y)

## HESS LAW

**154.** The enthalpy change of a reaction does not depend on
(1) State of reactants and products
(2) Nature of reactants and products
(3) Different intermediate reactions
(4) Initial and final enthalpy change of reaction

**155.** From the thermochemical reactions,
$C(graphite) + \frac{1}{2} O_2 \longrightarrow CO$ ; $\Delta H = -110.5$ kJ
$CO + \frac{1}{2} O_2 \longrightarrow CO_2$ ; $\Delta H = -283.2$ kJ
the heat of reaction of
$C(graphite) + O_2 \longrightarrow CO_2$ is :
(1) 393.7 kJ (2) – 393.7 kJ
(3) – 172.7 kJ (4) + 172.7 kJ

**156.** If $H_2 + \frac{1}{2} O_2 \longrightarrow H_2O$ ; $\Delta H = -68.39$ kCal
$K + H_2O + water \longrightarrow KOH(aq) + \frac{1}{2} H_2$ ; $\Delta H = -48.0$ kCal
$KOH + water \longrightarrow KOH\ (aq)$ $\Delta H = -14.0$ kCal
the heat of formation of KOH is -
(1) – 68.39 + 48 – 14.0
(2) – 68.39 – 48.0 +14.0
(3) +68.39 – 48.0 + 14.0
(4) + 68.39 + 48.0 – 14.0

**157.** Given $C(s) + O_2(g) \longrightarrow CO_2(g) + 94.2$ kCal
$H_2(g) + \frac{1}{2} O_2(g) \longrightarrow H_2O(\ell) + 68.3$ kCal

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell) + 210.8$ kCal

The heat of formation of methane in Kcal will be
(1) –45.9 (2) –47.8 (3) –20.0 (4) –47.3

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**158.** If, $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$ ;
$\Delta H^0 = -44$ kCal
$2Na(s) + 2HCl(g) \longrightarrow 2NaCl(s) + H_2(g)$;
$\Delta H^0 = -152$ kCal
Then, $Na(s) + 0.5\ Cl_2(g) \longrightarrow NaCl(s)$ ; $\Delta H^0 = ?$
(1) 108 kCal (2) 196 kCal
(3) – 98 kCal (4) 54 kCal

**159.** (i) $S(s) + 3/2\ O_2(g) \rightarrow SO_3(g) + 2x$ kCal
(ii) $SO_2(g) + ½\ O_2(g) \rightarrow SO_3(g) + y$ kCal
Calculate the heat of formation of $SO_2$ :
(1) (2x + y) (2) –(2x – y)
(3) x + y (4) 2x / y

**160.** If $S + O_2 \longrightarrow SO_2$ ; $\Delta H = -298.2$ kJ

$SO_2 + ½\ O_2 \longrightarrow SO_3$ ; $\Delta H = -98.7$ kJ

$SO_3 + H_2O \longrightarrow H_2SO_4$ ; $\Delta H = -130.2$ kJ

$H_2 + ½\ O_2 \longrightarrow H_2O$ ; $\Delta H = -287.3$ kJ

Then the enthalpy of formation of $H_2SO_4$ at 298 K is -

(1) –814.4 kJ (2) –650.3 kJ
(3) –320.5 kJ (4) –433.5 kJ

**161.** Given that :

$Zn + ½\ O_2 \rightarrow ZnO + 84000$ Cal

$Hg + ½\ O_2 \rightarrow HgO + 21700$ Cal

The heat of reaction ($\Delta H$) for,

$Zn + HgO \rightarrow ZnO + Hg$ is :-

(1) 105700 Cal (2) 62300 Cal
(3) –105700 Cal (4) – 62300 Cal

**162.** Given that -

$2C(s) + 2O_2(g) \rightarrow 2CO_2(g)$ $\Delta H = -787$ kJ

$H_2(g) + ½\ O_2(g) \rightarrow H_2O(\ell)$ $\Delta H = -286$ kJ

$C_2H_2(g) + \frac{5}{2} O_2(g) \rightarrow 2CO_2(g) + H_2O(\ell)$

$\Delta H = -1310$ kJ Heat of formation of acetylene is :-

(1) + 1802 kJ (2) – 1802 kJ
(3) – 800 kJ (4) + 237 kJ

**163.** The heat of reaction for

$A + \frac{1}{2} O_2 \rightarrow AO$ is - 50 kCal and

$AO + \frac{1}{2} O_2 \rightarrow AO_2$ is 100 kCal. The heat of reaction for $A + O_2 \rightarrow AO_2$ is:-

(1) – 50 kCal (2) + 50 kCal
(3) 100 kCal (4) 150 kCal

**164.** $C(s) + O_2(g) \rightarrow CO_2(g) + 94.0$ kCal

$CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$, $\Delta H = -67.7$ kCal

from the above reactions find how much heat (kCal $mole^{-1}$) would be produced in the following reaction : $C(s) + \frac{1}{2} O_2(g) \rightarrow CO(g)$

(1) 20.6 (2) 26.3 (3) 44.2 (4) 161.6

**165.** The enthalpy of vapourisation of liquid water using the data:

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(\ell)$ ; $\Delta H = -285.77$ kJ $mol^{-1}$

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g)$ ; $\Delta H = -241.84$ kJ $mol^{-1}$

(1) + 43.93 kJ $mol^{-1}$ (2) - 43.93 kJ $mol^{-1}$
(3) + 527.61 kJ $mol^{-1}$ (4) - 527.61 kJ $mol^{-1}$

**166.** $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(\ell)$ ;

$\Delta H_{298K} = -68.32$kCal. Heat of vapourisation of water at 1 atm and 25°C is 10.52 kCal. The standard heat of formation (in kCal) of 1 mole of water vapour at 25°C is

(1) 10.52 (2) –78.84 (3) +57.80 (4) –57.80

**167.** The heat of solution of anhydrous $CuSO_4$ and $CuSO_4.5H_2O$ are – 15.89 and 2.80 kCal $mol^{-1}$ respectively. What will be the heat of hydration of anhydrous $CuSO_4$ ?

(1) –18.69 kCal (2) 18.69 kCal
(3) –28.96 kCal (4) 28.96 kCal

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**168.** Which of the following expressions is true:-

(1) $H_f^0$ (CO,g)= $\frac{1}{2}$ $\Delta H_f^0$ ($CO_2$,g)

(2) $\Delta H_f^0$ (CO,g)

= $\Delta H_f^0$ (C,graphite) + $\frac{1}{2}$ $\Delta H_f^0$($O_2$,g)

(3) $\Delta H_f^0$ (CO,g) = $\Delta H_f^0$ ($CO_2$,g) – $\frac{1}{2}$ $\Delta H_f^0$ ($O_2$,g)

(4) $\Delta H_f^0$ (CO,g)

= $\Delta H_{comb}^0$ (C,graphite) – $\Delta H_{comb}^0$ (CO,g)

## EXERCISE-I (Conceptual Questions) ANSWER KEY

| Question | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Answer | 2 | 3 | 4 | 4 | 3 | 3 | 1 | 4 | 1 | 1 | 1 | 4 | 2 | 1 | 4 |
| Question | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| Answer | 4 | 4 | 1 | 1 | 3 | 1 | 3 | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 1 |
| Question | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| Answer | 1 | 1 | 2 | 3 | 4 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 3 | 4 |
| Question | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| Answer | 3 | 4 | 3 | 1 | 1 | 2 | 3 | 3 | 1 | 3 | 2 | 2 | 1 | 4 | 2 |
| Question | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 |
| Answer | 4 | 3 | 2 | 2 | 1 | 4 | 3 | 2 | 3 | 3 | 4 | 1 | 2 | 2 | 2 |
| Question | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| Answer | 4 | 1 | 4 | 1 | 4 | 1 | 1 | 2 | 3 | 1 | 3 | 4 | 1 | 2 | 4 |
| Question | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 |
| Answer | 2 | 4 | 2 | 1 | 2 | 4 | 4 | 2 | 2 | 2 | 4 | 4 | 1 | 2 | 2 |
| Question | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Answer | 3 | 2 | 3 | 4 | 4 | 4 | 1 | 3 | 2 | 1 | 3 | 1 | 3 | 2 | 2 |
| Question | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 |
| Answer | 2 | 2 | 3 | 1 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 4 |
| Question | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 |
| Answer | 2 | 3 | 2 | 3 | 2 | 3 | 4 | 3 | 3 | 1 | 1 | 3 | 2 | 4 | 4 |
| Question | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 |
| Answer | 3 | 2 | 1 | 3 | 2 | 2 | 3 | 3 | 2 | 1 | 4 | 4 | 2 | 2 | 1 |
| Question | 166 | 167 | 168 | | | | | | | | | | | | |
| Answer | 4 | 1 | 4 | | | | | | | | | | | | |

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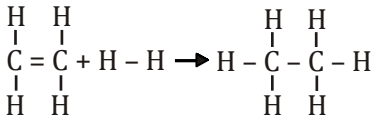
## Exercise - II (Previous Year Questions) AIPMT/NEET

### AIPMT 2009

**1.** From the following bond energies :-
H – H bond energy : 431.37 kJ $mol^{-1}$
C = C bond energy : 606.10 kJ $mol^{-1}$
C – C bond energy : 336.49 kJ $mol^{-1}$
C – H bond energy : 410.50 kJ $mol^{-1}$
Enthalpy for the reaction,



will be :-
(1) 553.0 kJ $mol^{-1}$ (2) 1523.6 kJ $mol^{-1}$
(3) –243.6 kJ $mol^{-1}$ (4) –120.0 kJ $mol^{-1}$

**2.** The values of $\Delta H$ and $\Delta S$ for the reaction, $C_{(graphite)} + CO_{2(g)} \rightarrow 2CO_{(g)}$ are 170 kJ and 170 $JK^{-1}$, respectively. This reaction will be spontaneous at :-
(1) 510 K (2) 710 K (3) 910 K (4) 1110 K

### AIPMT 2010

**3.** For vaporization of water at 1 atmospheric pressure, the values of $\Delta H$ and $\Delta S$ are 40.63 kJ $mol^{-1}$ and 108.8 $JK^{-1}mol^{-1}$, respectively. The temperature when Gibbs energy change ($\Delta G$) for this transformation will be zero, is :-
(1) 393.4 K (2) 373.4 K
(3) 293.4 K (4) 273.4 K

**4.** Three moles of an ideal gas expanded spontaneously into vacuum. The work done will be :-
(1) 3 Joule (2) 9 Joule
(3) Zero (4) Infinite

**5.** The following two reactions are known :
$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$ ;
$\Delta H = -26.8$ kJ
$FeO(s) + CO(g) \rightarrow Fe(s) + CO_2(g)$ ;
$\Delta H = -16.5$ kJ
Correct target equation is
$Fe_2O_3(s) + CO(g) \rightarrow 2FeO(s) + CO_2(g)$, $\Delta H$ =?
(1) –43.3 kJ (2) –10.3 kJ
(3) + 6.2 kJ (4) + 10.3 kJ

**6.** Standard entropies of $X_2$, $Y_2$ and $XY_3$ are 60, 40 and 50 $JK^{-1}$ $mol^{-1}$ respectively. For the reaction

$$\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightleftharpoons XY_3,\ \Delta H = -30 \text{ kJ}$$

to be at equilibrium, the temperature should be :-
(1) 500 K (2) 750 K
(3) 1000 K (4) 1250 K

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### AIPMT Pre. 2011

**7.** If the enthalpy change for the transition of liquid water to steam is 30 kJ $mol^{-1}$ at 27°C, the entropy changes for the process would be:
(1) 10 J $mol^{-1}$ $K^{-1}$ (2) 1.0 J $mol^{-1}$ $K^{-1}$
(3) 0.1 J $mol^{-1}$ $K^{-1}$ (4) 100 J $mol^{-1}$ $K^{-1}$

**8.** Enthalpy change for the reaction,
$4H_{(g)} \rightarrow 2H_{2(g)}$ is –869.6 kJ
The dissociation energy of H–H bond is :
(1) –434.8 kJ (2) 869.6 kJ
(3) +434.8 kJ (4) +217.4 kJ

**9.** Which of the following correct option for free expansion of an ideal gas under adiabatic condition ?
(1) $q = 0, \Delta T \neq 0, w = 0$
(2) $q \neq 0, \Delta T = 0, w = 0$
(3) $q = 0, \Delta T = 0, w = 0$
(4) $q = 0, \Delta T < 0, w \neq 0$

### AIPMT Mains 2011

**10.** Consider the following processes :-

| $\Delta H$ (kJ $mol^{-1}$) | |
|---|---|
| $\frac{1}{2}A \rightarrow B$ | +150 |
| $3B \rightarrow 2C + D$ | –125 |
| $E + A \rightarrow 2D$ | +350 |

For $B + D \rightarrow E + 2C$, $\Delta H$ will be :
(1) 325 kJ $mol^{-1}$ (2) 525 kJ $mol^{-1}$
(3) –175 kJ $mol^{-1}$ (4) –325 kJ $mol^{-1}$

### AIPMT Pre. 2012

**11.** In which of the following reactions, standard reaction entropy change ($\Delta S°$) is positive and standard Gibb's energy change ($\Delta G°$) decreases sharply with increasing temperature?

(1) $Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$

(2) $\frac{1}{2}C\text{ (graphite)} + \frac{1}{2}O_2(g) \rightarrow \frac{1}{2}CO_2(g)$

(3) $C\text{ (graphite)} + \frac{1}{2}O_2(g) \rightarrow CO(g)$

(4) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

**12.** Standard enthalpy of vapourisation $\Delta_{vap}H^{\circ}$ for water at 100°C is 40.66 kJmol$^{-1}$. The internal energy of vaporisation of water at 100°C (in kJmol$^{-1}$) is
(1) +43.76 (2) +40.66 (3) +37.56 (4) –43.76

**13.** The enthalpy of fusion of water is 1.435 kCal mol$^{-1}$. The molar entropy change for the melting of ice at 0°C is:
(1) 5.260 Cal mol$^{-1}$ K$^{-1}$ (2) 0.526 Cal mol$^{-1}$ K$^{-1}$
(3) 10.52 Cal mol$^{-1}$ K$^{-1}$ (4) 21.04 Cal mol$^{-1}$ K$^{-1}$

## AIPMT 2014

**14.** For the reaction : $X_2O_4(\ell) \longrightarrow 2XO_2(g)$
$\Delta U = 2.1$ kCal, $\Delta S = 20$ cal K$^{-1}$ at 300 K
Hence $\Delta G$ is :-
(1) 2.7 kCal (2) – 2.7 kCal
(3) 9.3 kCal (4) – 9.3 kCal

## AIPMT 2015

**15.** Which of the following statements is **correct** for a reversible process in a state of equilibrium ?
(1) $\Delta G = 2.30$ RT log K (2) $\Delta G^{\circ} = -2.30$ RT log K
(3) $\Delta G^{\circ} = 2.30$ RT log K (4) $\Delta G = -2.30$ RT log K

## Re-AIPMT 2015

**16.** The heat of combustion of carbon to $CO_2$ is –393.5 kJ mol$^{-1}$. The heat exchange in the formation of 35.2 g of $CO_2$ from carbon and oxygen gas is:
(1) –630 kJ (2) –3.15 kJ
(3) –315 kJ (4) +315 kJ

## NEET-I 2016

**17.** The correct thermodynamic conditions for the spontaneous reaction at all temperatures is
(1) $\Delta H > 0$ and $\Delta S > 0$ (2) $\Delta H > 0$ and $\Delta S < 0$
(3) $\Delta H < 0$ and $\Delta S > 0$ (4) $\Delta H < 0$ and $\Delta S < 0$

## NEET-II 2016

**18.** For a sample of perfect gas when its pressure is changed isothermally from $p_i$ to $p_f$, the entropy change is given by
(1) $\Delta S = nRT \ln \left(\frac{p_f}{p_i}\right)$ (2) $\Delta S = RT \ln \left(\frac{p_i}{p_f}\right)$
(3) $\Delta S = nR \ln \left(\frac{p_f}{p_i}\right)$ (4) $\Delta S = nR \ln \left(\frac{p_i}{p_f}\right)$

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## NEET(UG) 2017

**19.** For a given reaction, $\Delta H = 35.5$ kJ mol$^{-1}$ and $\Delta S = 83.6$ JK$^{-1}$mol$^{-1}$. The reaction is spontaneous at : (Assume that $\Delta H$ and $\Delta S$ do not vary with temperature)
(1) T > 425 K (2) All temperatures
(3) T > 298 K (4) T < 425 K

**20.** A gas is allowed to expand in a well insulated container against a constant external pressure of 2.5 atm from an initial volume of 2.50 L to a final volume of 4.50 L. The change in internal energy $\Delta U$ of the gas in joules will be:-
(1) –500 J (2) –505 J
(3) +505 J (4) 1136.25 J

## NEET (UG) 2018

**21.** The bond dissociation energies of $X_2$, $Y_2$ and XY are in the ratio of 1 : 0.5 : 1. $\Delta H$ for the formation of XY is –200 kJ mol$^{-1}$. The bond dissociation energy of $X_2$ will be
(1) 200 kJ mol$^{-1}$ (2) 100 kJ mol$^{-1}$
(3) 800 kJ mol$^{-1}$ (4) 400 kJ mol$^{-1}$

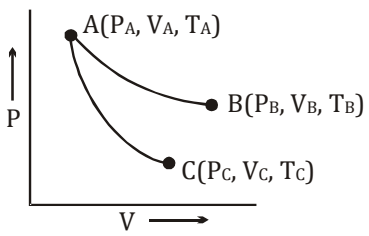
## NEET(UG) 2019

**22.** Under isothermal condition, a gas at 300 K expands from 0.1L to 0.25L against a constant external pressure of 2 bar. The work done is :- [Given that 1L bar = 100 J]
(1) –30 J (2) 5kJ (3) 25 J (4) 30 J

## NEET(UG) 2019 (Odisha)

**23.** An ideal gas expands isothermally from $10^{-3}$ m$^3$ to $10^{-2}$ m$^3$ at 300 K against a constant pressure of $10^5$ Nm$^{-2}$. The work, in the process is :-
(1) +270 kJ (2) –900 J
(3) +900 kJ (4) –900 kJ

**24.** Reversible expansion of an ideal gas under isothermal and adiabatic conditions are as shown in the figure.



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AB → Isothermal expansion
AC → Adiabatic expansion
Which of the following options is **not** correct ?
(1) $\Delta S_{isothermal} > \Delta S_{adiabatic}$ (2) $T_A = T_B$
(3) $W_{isothermal} > W_{adiabatic}$ (4) $T_c > T_A$

## NEET (UG) 2020

**25.** The correct option for free expansion of an ideal gas under adiabatic condition is :
(1) $q > 0, \Delta T > 0$ and $w > 0$
(2) $q = 0, \Delta T = 0$ and $w = 0$
(3) $q = 0, \Delta T < 0$ and $w > 0$
(4) $q < 0, \Delta T = 0$ and $w = 0$

**26.** Hydrolysis of sucrose is given by the following reaction.
Sucrose + $H_2O \rightleftharpoons$ Glucose + Fructose
If the equilibrium constant ($K_c$) is $2 \times 10^{13}$ at 300K, the value of $\Delta_r G^1$ at the same temperature will be:
(1) $-8.314\ J\ mol^{-1}\ K^{-1} \times 300\ K \times \ln(4 \times 10^{13})$
(2) $-8.314\ J\ mol^{-1}\ K^{-1} \times 300\ K \times \ln(2 \times 10^{13})$
(3) $8.314\ J\ mol^{-1}\ K^{-1} \times 300\ K \times \ln(2 \times 10^{13})$
(4) $8.314\ J\ mol^{-1}\ K^{-1} \times 300\ K \times \ln(3 \times 10^{13})$

**27.** For the reaction $2Cl(g) \rightarrow Cl_2(g)$, the **correct** option is:
(1) $\Delta_r H < 0$ and $\Delta_r S < 0$
(2) $\Delta_r H > 0$ and $\Delta_r S > 0$
(3) $\Delta_r H > 0$ and $\Delta_r S < 0$
(4) $\Delta_r H < 0$ and $\Delta_r S > 0$

## NEET (UG) 2020 (Covid-19)

**28.** If for a certain reaction $\Delta_r H$ is 30 kJ $mol^{-1}$ at 450 K, the value of $\Delta_r S$ (in $JK^{-1}\ mol^{-1}$) for which the same reaction will be spontaneous at the same temperature is
(1) 70 (2) –33 (3) 33 (4) –70

**29.** At standard conditions, if the change in the enthalpy for the following reaction is –109 kJ $mol^{-1}$ $H_{2(g)} + Br_{2(g)} \rightarrow 2HBr_{(g)}$
Given that bond energy of $H_2$ and $Br_2$ is 435 kJ $mol^{-1}$ and 192 kJ $mol^{-1}$, respectively, what is the bond energy (in kJ $mol^{-1}$) of HBr?
(1) 368 (2) 736 (3) 518 (4) 259

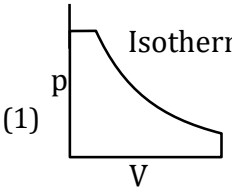
## NEET (UG) 2021

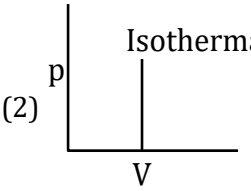
**30.** Which one among the following is the correct option for right relationship between $C_P$ and $C_V$ for one mole of ideal gas ?
(1) $C_P + C_V = R$ (2) $C_P - C_V = R$
(3) $C_P = RC_V$ (4) $C_V = RC_P$

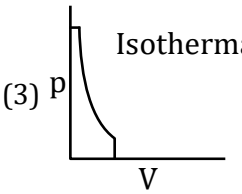
**31.** For irreversible expansion of an ideal gas under isothermal condition, the correct option is :
(1) $\Delta U = 0, \Delta S_{total} = 0$ (2) $\Delta U \neq 0, \Delta S_{total} \neq 0$
(3) $\Delta U = 0, \Delta S_{total} \neq 0$ (4) $\Delta U \neq 0, \Delta S_{total} = 0$

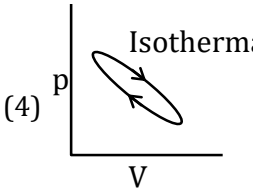
## NEET (UG) 2022

**32.** Which of the following p-V curve represents maximum work done ?

(1) 


(2) 


(3) 


(4) 


**33.** One mole of an ideal gas at 300 K is expanded isothermally from 1 L to 10 L volume. $\Delta U$ for this process is (Use R = 8.314 J $K^{-1}$ $mol^{-1}$)
(1) 1260 J (2) 2520 J
(3) 5040 J (4) 0 J

## EXERCISE-II (Previous Year Questions) ANSWER KEY

| Question | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Answer | 4 | 4 | 2 | 3 | 3 | 2 | 4 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 |
| Question | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| Answer | 3 | 3 | 4 | 1 | 2 | 3 | 4 | 2 | 4 | 2 | 2 | 1 | 1 | 1 | 2 |
| Question | 31 | 32 | 33 | | | | | | | | | | | | |
| Answer | 3 | 1 | 4 | | | | | | | | | | | | |

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## Exercise – III (Analytical Questions) Master Your Understanding

**1.** Given below are two statements :

**Statement I :** A process is said to be reversible, if a change is brought out in such a way that the process could, at any moment, be reversed by an infinitesimal change.

**Statement II :** A reversible process proceeds by a series of equilibrium states such that system and surroundings are near equilibrium with each other.

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both statement I and statement II are incorrect.

(2) Statement I is correct but statement II is incorrect

(3) Statement I is incorrect but statement II is correct.

(4) Both statement I and statement II are correct.

**2.** **Statement I :** Combustion of all organic compounds is an exothermic reaction.

**Statement II :** The enthalpy of formation of all elements in their stable and standard states is zero.

(1) Both statement I and statement II are incorrect.

(2) Statement I is correct but statement II is incorrect

(3) Statement I is incorrect but statement II is correct.

(4) Both statement I and statement II are correct.

**3.** Given below are two statements:

**Statement I :** $C_{pm} - C_{vm} = R$ is applicable for all gases.

**Statement II** : $C_{pm} - C_{vm} = R$ is applicable for ideal gas only.

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both statement I and statement II are incorrect.

(2) Statement I is correct but statement II is incorrect.

(3) Statement I is incorrect but statement II is correct.

(4) Both statement I and statement II are correct.

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**4.** Which of the following is incorrect?

(1) For isothermal reversible process

$$W_{pv} = -nRT \ln\left(\frac{P_1}{P_2}\right)$$

(2) For any irreversible process

$W_{pv} = -P_{ext}(V_2 - V_1)$

(3) For isothermal irreversible change

$$W_{pv} = nRT \ln\left[\frac{V_2}{V_1}\right]$$

(4) For adiabatic reversible process $\Delta U = W_{ad}$

**5.** Which of the following is correct -

(1) $\Delta U$ is calculated at constant volume and pressure

(2) $\Delta H$ is calculated at constant volume only

(3) $\Delta S$ is calculated at constant volume only

(4) $\Delta G$ calculated at constant temperature and pressure is used to decide spontaneity.

**6.** Which of the following is not correct –

(1) $(\Delta G)_{T,P}$ is zero at equilibrium

(2) $(\Delta G)_{T,P} > 0$ for a spontaneous reaction

(3) $(\Delta G)_{T,P} < 0$ for a spontaneous reaction

(4) $(\Delta G)_{T,P} > 0$ for a nonspontaneous reaction

**7.** Match List – I with List- II.

| List – I | | List - II | |
|---|---|---|---|
| (a) | Entropy of vapourisation | (i) | $\Delta S$ = negative |
| (b) | $\Delta U$ in reversible adiabatic expansion of an ideal gas | (ii) | Decreases |
| (c) | Crystalline solid state | (iii) | Lowest entropy |
| (d) | A liquid freezes | (iv) | $\frac{\Delta H_{vap}}{T_b}$ |

(1) (a) – (iv), (b) – (ii), (c) – (iii), (d) – (i)

(2) (a) – (iii), (b) – (ii), (c) – (iv), (d) – (i)

(3) (a) – (iv), (b) – (i), (c) – (iii), (d) – (ii)

(4) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

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**8.** Predict in which of the following entropy increases.
(a) A liquid crystallizes into a solid
(b) Temperature of a crystalline solid is raised from 0 K to 115 K
(c) $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$
(d) $H_2(g) \rightarrow 2H(g)$
The correct one is –
(1) a, b (2) b, c, d
(3) a, b, c (4) a, b, c and d

**9.** In a given process for an ideal gas $w = 0$ and $q < 0$ for gas.
The correct one is :
(1) Temperature will decrease.
(2) Volume will increase.
(3) Pressure remains constant
(4) Temperature will increase

**10.** Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.
**Assertion (A):** $\Delta H_f^\circ$ for $H_2(g)$, and $Cl_2(g)$ is zero.
**Reason (R):** $\Delta H_f^\circ$ for every element in its stable and standard state is zero.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Both **(A)** and **(R)** are correct but **(R)** is not the correct explanation of **(A).**
(2) **(A)** is correct but **(R)** is not correct.
(3) **(A)** is not correct but **(R)** is correct.
(4) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A).**

**11.** Given below are two statements:
**Statement I :** All natural processes are spontaneous.
**Statement II** : All natural processes are irreversible.
(1) Both statement I and statement II are incorrect.
(2) Statement I is correct but statement II is incorrect
(3) Statement I is incorrect but statement II is correct.
(4) Both statement I and statement II are correct.

**12.** **Statement I :** A molar property $(X_m) = \frac{X}{n}$
where $X \rightarrow$ is the value of an extensive property.
$n \rightarrow$ is mole of matter, so $X_m$ is an intensive property.
**Statement II** : An extensive property is a property whose value depends on quantity of matter.
(1) Both statement I and statement II are incorrect.
(2) Statement I is correct but statement II is incorrect
(3) Statement I is incorrect but statement II is correct.
(4) Both statement I and statement II are correct.

**13.** Which of the following pairs for a chemical reaction is certain to result in a spontaneous reaction.
(1) Exothermic and decreasing disorderness.
(2) Exothermic and increasing disorderness.
(3) Endothermic and increasing disorderness.
(4) Endothermic and decreasing disorderness.

**14.** Given below are two statements:
**Statement I :** In an isolated system there is no exchange of energy but exchange of matter is possible between system and the surroundings.
**Statement II** : The presence of reactants in a thermous flask is an example of an isolated system.
In the light of the above statements, choose the **most appropriate** answer from the options given below :
(1) Both statement I and statement II are incorrect.
(2) Statement I is correct but statement II is incorrect
(3) Statement I is incorrect but statement II is correct.
(4) Both statement I and statement II are correct.

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**15.** Given below are two statements:

**Statement I :** Natural processes are irreversible and spontaneous in nature.

**Statement II** : Decrease in enthalpy is a contributory factor for spontaneity.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) Both statement I and statement II are incorrect.

(2) Statement I is correct but statement II is incorrect

(3) Statement I is incorrect but statement II is correct.

(4) Both statement I and statement II are correct.

**16.** Given below are two statements:

**Statement I :** The entropy decreases when the temperature of a crystalline solid is raised from 0K to 115K.

**Statement II** : On raising temperature 0K to 115K the entropy increases.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) Both statement I and statement II are incorrect.

(2) Statement I is correct but statement II is incorrect

(3) Statement I is incorrect but statement II is correct.

(4) Both statement I and statement II are correct.

**17.** Given below are two statements:

**Statement I :** If both $\Delta H^\circ$ and $\Delta S^\circ$ are positive then reaction will be spontaneous at high temperature.

**Statement II** : All process with positive entropy change are spontaneous.

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both statement I and statement II are incorrect.

(2) Statement I is correct but statement II is incorrect

(3) Statement I is incorrect but statement II is correct.

(4) Both statements I and statements II are correct.

**18.** Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

**Assertion (A)** : Enthalpy of neutralization of reaction.

$HF + NaOH \longrightarrow NaF + H_2O$ is – 16.7 Kcal/eq.

**Reason (R) :** HF is a strong acid so, its enthalpy of neutralization increases with strong base.

In the light of the above statements choose the **most appropriate** answer from the options given below

(1) Both **(A)** and **(R)** are correct but **(R)** is not the correct explanation of **(A)**.

(2) **(A)** is correct but **(R)** is not correct.

(3) **(A)** is not correct but **(R)** is correct.

(4) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A).**

**19.** Match List – I with List – II.

| List – I | | List - II | |
|---|---|---|---|
| (a) | $p_{ext.} = 0$ | (i) | Adiabatic change |
| (b) | $q = p_{ext.}(v_f - v_i)$ | (ii) | free expansion of an ideal gas |
| (c) | $q = 2.303\ nRT \log\left(\frac{v_f}{v_i}\right)$ | (iii) | isothermal irreversible change |
| (d) | $\Delta U = W$ | (iv) | isothermal reversible change |

Choose the correct answer from the options given below:

(1) (a) – (ii), (b) – (iv), (c) – (iii), (d) – (i)

(2) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)

(3) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

(4) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)

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**20.** Match List – I with List – II.

| List – I | | List - II | |
|---|---|---|---|
| (a) | $H_2O(s) \xrightarrow[1atm]{0^\circ C} H_2O(l)$ | (i) | $\Delta G = -ve$, $\Delta S = +ve$ |
| (b) | $H_2O(s) \xrightarrow[1atm]{10^\circ C} H_2O(l)$ | (ii) | $\Delta G = +ve$, $\Delta S = +ve$ |
| (c) | $H_2O(s) \xrightarrow[1atm]{-10^\circ C} H_2O(l)$ | (iii) | $\Delta G = 0$, $\Delta S = +ve$ |
| (d) | On addition of HCl in $Ag^+$ solution | (iv) | $\Delta G = -ve$, $\Delta S = -ve$ |

Choose the correct answer from the options given below:

(1) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)

(2) (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)

(3) (a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)

(4) (a) – (i), (b) – (iii), (c) – (ii), (d) – (iv)

**21.** Identify the correct set of statements for

$\Delta S_{Total} = -80$ KJ $K^{-1}$ $mol^{-1}$, $\Delta H_{System} = 4000 \frac{kJ}{mol}$

Temperature = 800K

(a) $\Delta G = +64000$ KJ $mol^{-1}$

(b) $\Delta S_{System} = +75$ KJ $mol^{-1}$

(c) Reaction is non-spontaneous

(d) Reaction is spontaneous

Choose the correct answer from the options given below:

(1) (a) & (b) only (2) (a), (b), (c)

(3) (a), (c), (d) only (4) (a), (c) only

**22.** Identify the correct set of statements

(a) Heat of neutralisation of 0.3 mole HCl with 1 mole NaOH is –4.11 Kcal

(b) For $H_2O$ (liquid), $\Delta H_f$ is more negative in comparison to the formation of $H_2O$ (vapour)

(c) Heat of combustion of $H_2(g)$ is equal to heat of formation of $H_2O(l)$

(d) Heat of hydrogenation is always endothermic in nature.

Choose the correct answer from the options given below:

(1) (a), (b) only (2) (a), (b) & (c) only

(3) (c) & (d) only (4) (b), (d) only

## EXERCISE-III (Analytical Questions) ANSWER KEY

| Question | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Answer | 4 | 4 | 3 | 3 | 4 | 2 | 1 | 2 | 1 | 4 | 4 | 4 | 2 | 3 | 4 |
| Question | 16 | 17 | 18 | 19 | 20 | 21 | 22 | | | | | | | | |
| Answer | 3 | 2 | 2 | 2 | 3 | 4 | 2 | | | | | | | | |

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# Important Notes